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Laser cladding process development for high carbon steel substrates

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ABSTRACT

This paper evaluates the effect of process parameters (laser power and scanning velocity) on clad layer height, heat affected zone (HAZ) width, metallurgical bonding to base metal and Vickers microhardness profiles of clad layers of various composition. A 3 kW IPG Fiber laser was used to clad St1.7339 powder on a high carbon steel substrate (EN9). The laser power and scanning velocity were varied between 2 kW to 2.5 kW and 0.5 m/min to 1.2 m/min respectively. The carrier gas flow rate, laser beam spot diameter and powder feed rate were kept constant throughout the experiment. The effect of multiple layers (up to a total of six clad layers built-up) and post-weld heat treatment by a defocussed laser beam on the HAZ width and hardness were investigated respectively. The produced clads were prepared for metallurgical evaluation and were analysed for microstructure using optical microscopopy and microhardness traverse were done using a Vickers microhardness tester. The clad height, HAZ width and its metallurgical bonding were observed and measured with an optical microscope equipped with image analysis software. All the samples that were evaluated showed sound metallurgical bonding with the substrate. A decrease in porosity was observed with an increase in laser power at constant scan speed. The hardness values taken on the HAZ showed a decrease with the increase in the number of clad layers during build-up. Meanwhile, four clad layer build up samples showed similar hardness trend independent of the laser power used. The width of the HAZ did not increase with an increase in the number of clad layers built-up. Laser post-weld heat treatment on the clad proved to be feasible as results indicated HAZ hardness was significantly decreased. Using AISI 316L as a butter layer did not lead to the formation of hard brittle chromium carbides even though the chromium content is high enough for the formation of these stable carbides. It was however observed that the use of an AISI 316L butter layer did result in a wider HAZ compared to the pure iron and medium carbon steel butter layers.